New Three-Dimensional Carotid Ultrasound in Plaque and Artery Volume Measurements. Comparison with Standard Assessment of Carotid Artery Stenosis.

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INTRODUCTION:

There is an appealing need in non-invasive and accurate techniques for assessment of severity of atherosclerotic disease. Recently an automated single sweep three-dimensional ultrasound (3D US) technique became available. The aims of this study were to elaborate a volumetric method for assessment of carotid artery stenosis, to evaluate the reproducibility of the automated single sweep method for measures obtained, and assess agreement in classification of stenosis by standard methods in a cohort of patients undergoing clinically indicated carotid ultrasound.

OBJECTIVES:

1. To assess the reproducibility of single sweep three dimensional ultrasound in carotid artery plaque and artery volume measurements, and
2. To assess agreement in classification of stenosis between 3D volumetric and standard Doppler methods.

METHODS:

73 consecutive patients with history of Stroke or TIA clinically indicated for carotid ultrasound and having a measurable plaque were recruited in this study. 3D ultrasound was performed using a Philips iU 22 ultrasound system equipped with the single sweep volumetric transducer vL 13-5. The analysis was performed offline with Q-lab 8.1 software (Philips) (Figure 1). Two independent observers measured volumes of plaques and arteries.

The ICA stenosis degree by volume reduction method was calculated using the following equation:

*Stenosis = PV/AV*100*,

where PV is Plaque Volume, AV is the segmental arterial volume. The severity of the stenosis was classified into three groups: 1-49%, 50-69%, >70% stenosis. These results were compared to those from standard carotid Doppler examination.

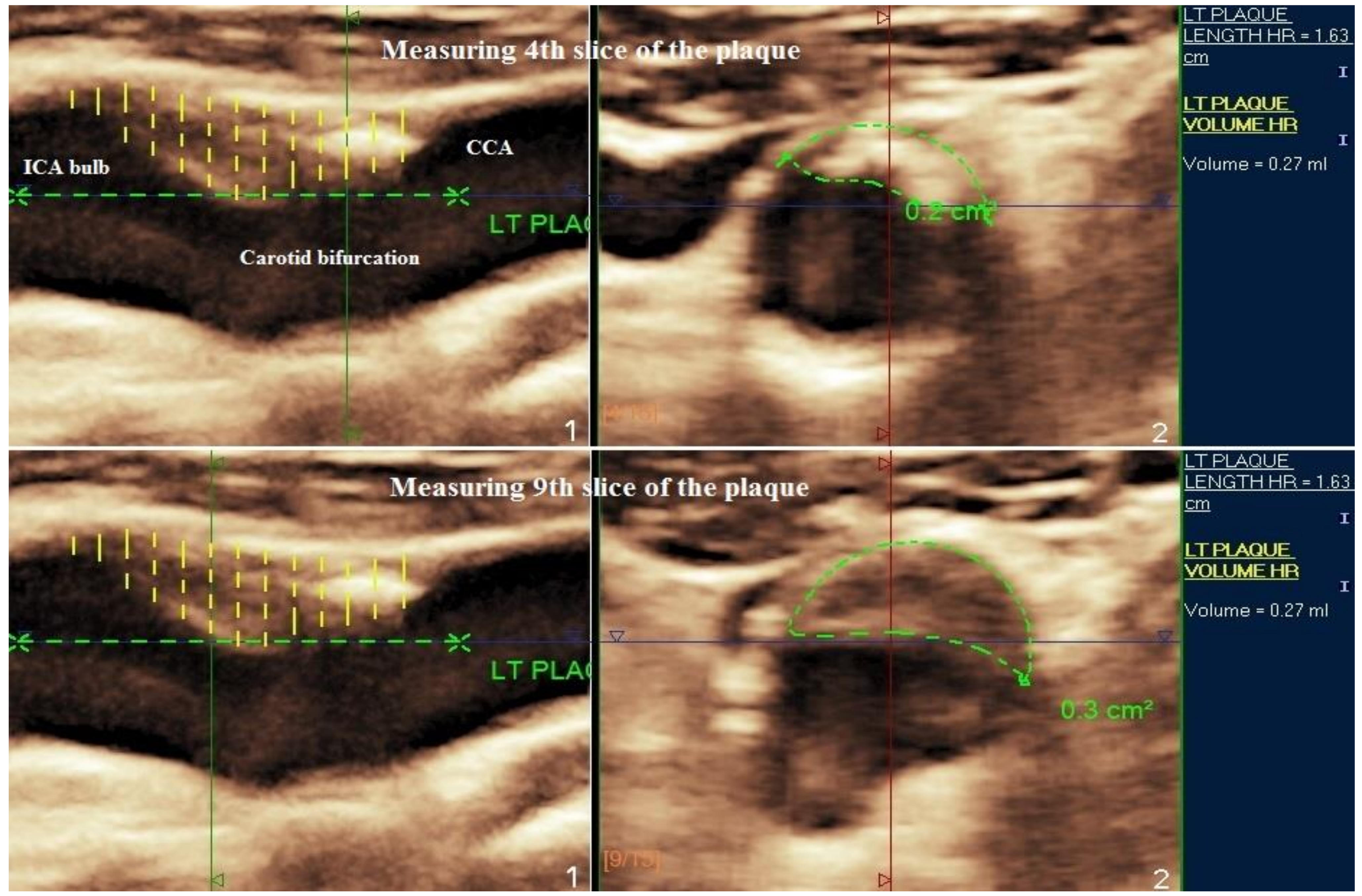

Figure 1. Plaque volume measurement using Q-lab software: the plaque is sliced along the carotid artery. Two slices are shown from a total of 11 slices in which the area of the plaque is manually traced. The plaque volume is calculated by summing up the volumes of the slices (area x slice thickness).

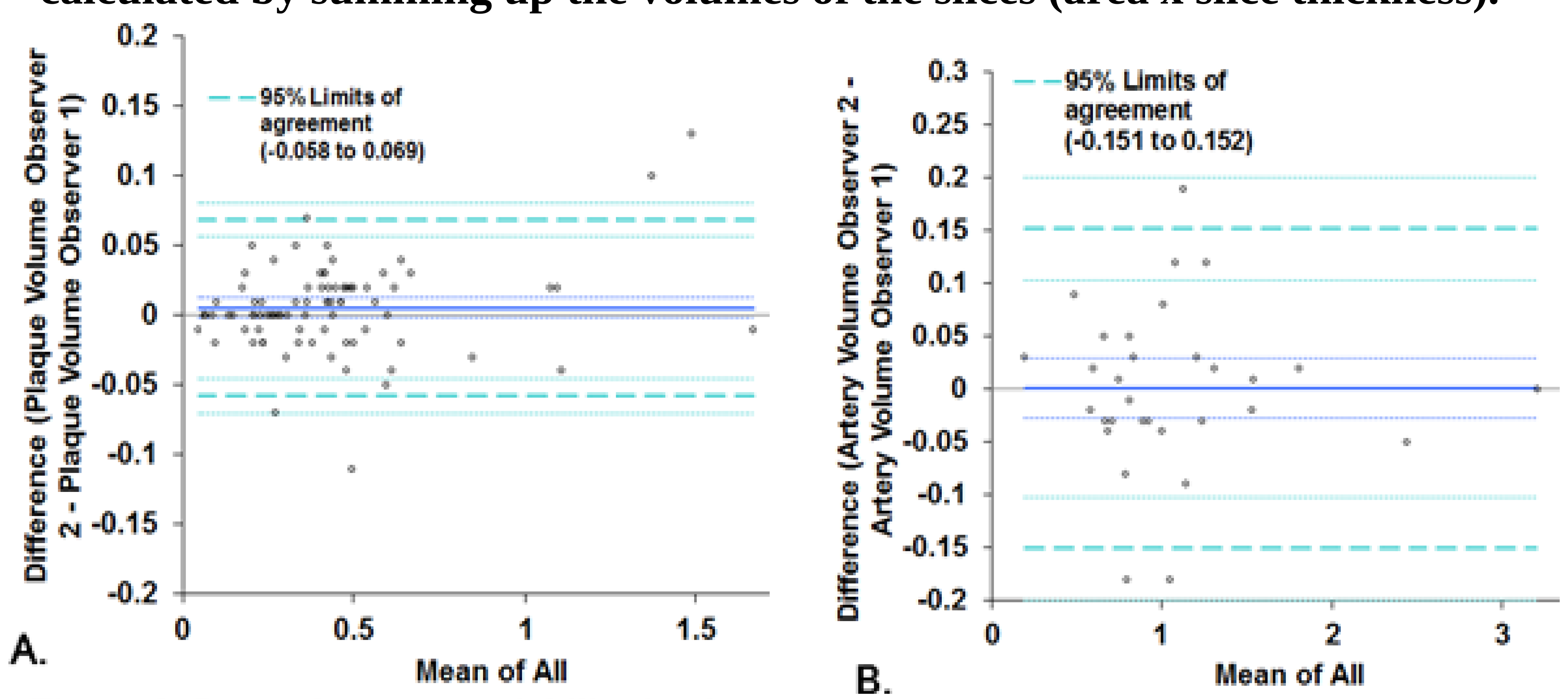

Figure 2. Inter-observer variability in plaque (A) and artery (B) volume measurements using Bland-Altman analysis

RESULTS:

of 121 arteries studied (from 73 patients), plaque and artery volumes could be measured in 98 (81%). Reproducibility of plaque volume measurements was assessed in 82 arteries. Bland Altman analysis demonstrated good inter-observer reproducibility with limits of agreement -0.058ml to 0.069ml (Figure 2A). The mean percentage change between two observers was 5.6% ± 6.02%. Reproducibility of artery volume measurement was assessed in 33 cases. Bland-Altman analysis demonstrated limits of agreement from -0.028 to 0.029 (Figure 2B). The mean percentage change was 6.4 ± 5.9%.

The agreement between conventional Doppler and volumetric methods of stenosis measurement was assessed in 98 arteries by Kappa value=0.43 (Table1).

Table 1. Comparison of spectral and 3D volumetric methods for assessment the carotid stenosis using cross tabulation

		3D Volume Reduction			Total
		01-49	50-69	70-99	
Standard Doppler	01-49	69	8	0	77
	50-69	6	8	1	15
	70-99	1	4	1	6
Total		76	20	2	98

CONCLUSIONS:

The new automated single sweep 3D ultrasound method shows good reproducibility in plaque and artery volume measurements with the acquisition time < 2s. Moderate agreement between 3D volume reduction and conventional velocity-based method in carotid artery stenosis measurement was found.